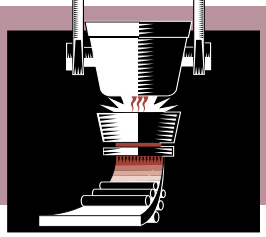
Technology Success Story

STEEL



# Dilute Oxygen Combustion (DOC) System

**Benefits**

- Reduced fuel required to operate furnace by up to 50 percent over air-fuel combustion
- Reduced NOx emissions to less than 0.015 lb.MMBtu
- Increased furnace productivity 10 to 30 percent over air-fuel combustion
- Low capital investment and operating costs
- Uniform heating of steel resulting in improved rolling mill performance and lower reject rates
- Simple and inexpensive to install compared to conventional flue gas recirculation systems

"The Dilute Oxygen Combustion technology delivered a dramatic increase in production rate while maintaining excellent NOx performance for Auburn Steel. The DOC technology accomplished this without high capital, operating and maintenance costs."

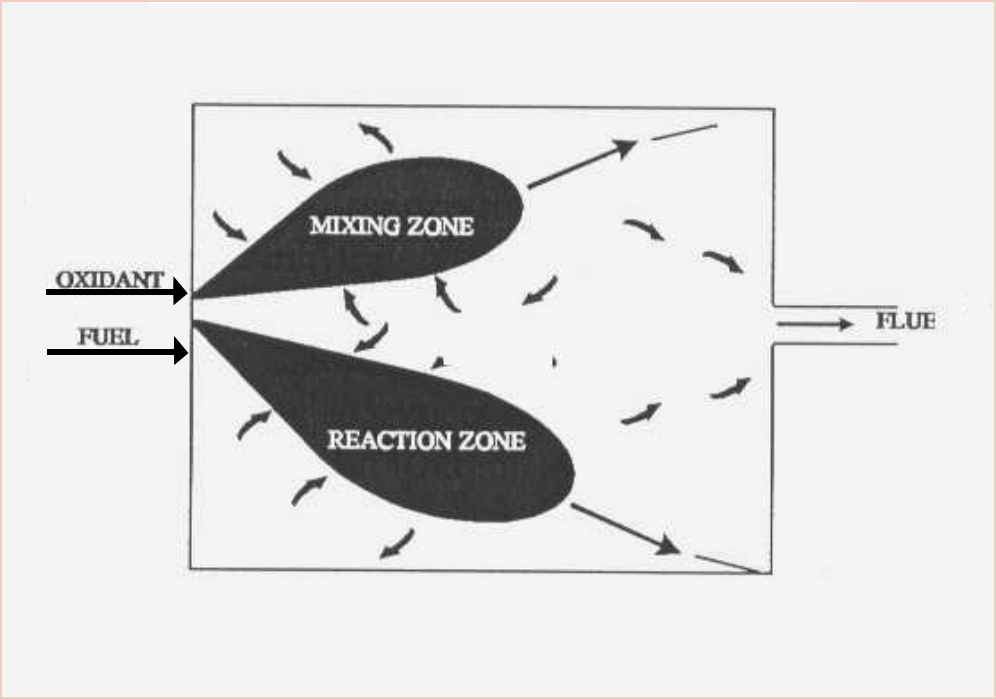
--- Michael F. Riley, Senior Development Associate, Praxair, Inc.

## New combustion technology improves reheat furnace productivity while reducing $NO_x$ emissions

Hot rolling mills are used during steel production to finish cast steel. In hot rolling, continuous strands or slabs of steel are reheated and pulled through a series of rolls that shape them into coils or sheets. The shapes, coils and sheets may then undergo further forming and finishing, or be sold in this form. During the hot rolling process, reheat furnaces are used to heat the steel to approximately 2,000°F. The combustion that takes place in these furnaces generate NOx emissions, which need to be reduced due to increasingly strict environmental regulations.

A demand has therefore grown for new low-NOx combustion technologies to help the steel and other industries comply with environmental regulations while maintaining low capital and operating costs. This is technically difficult because a reduction in NOx emissions can result in decreased productivity. Development of a low-NOx emission furnace that can provide superior performance would be a great asset to the steel industry.

### Dilute Oxygen Combustion System




**Schematic representation of Dilute Oxygen Combustion.**

## Solution

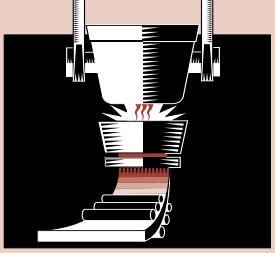
The Dilute Oxygen Combustion (DOC) system is emerging as a promising technology because it both reduces NOx emissions and increases productivity. Potential fuel savings are an additional benefit of this new combustion technology.

The DOC system injects fuel gas and oxygen into the furnace through two distinct, high velocity jets. Traditional furnaces use only one burner, through which both gases enter the furnace. By using two separate jets, the fuel gas and oxygen are heated by the furnace gases before reacting with each other. The dilution effect of the gases mixing in the furnace prevents high peak flame temperatures and significantly reduces NOx generation, even with a high nitrogen content in the furnace. The DOC system also differs from the traditional furnace by injecting oxygen instead of air. This results in a reduction of fuel use and yields lower flue gas temperatures. Furthermore, the diffuse flame in the DOC system heats the the steel more uniformly, leading to improved quality and mill performance. The overall benefits provided by the system design allow the DOC furnace to run economically at higher production rates.

## Results

Following project inception in 1995, the DOC system was developed with extensive laboratory and pilot-scaled modeling to study the mixing of reactive jets. Once the data was collected, a commercial DOC system was built and installed in 1999 at the Auburn Steel Company, Inc. steel mill in Auburn, New York. Since then, the commercial system has been successfully operating in a reheat furnace at this mill. The DOC system has enabled Auburn to increase the maximum production rate by 33 percent without significant capital investment. Praxair, Inc. continues to market the DOC system, with several customers expressing interest.

A similar system, using essentially the same combustion technology, has also been implemented at Bethlehem Steel Corporation under a NICE$^3$ project. The system has provided significant cost and fuel savings and NOx emission reductions for Bethlehem Steel, who is considering the conversion of two additional furnaces.

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February 2001